Nanostructured materials | Jožef Stefan Institute Ljubljana, Slovenia

SEMINAR II

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Grain boundary engineering of recycled Nd-Fe-b permanent magnets

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Recycling Nd-Fe-B magnets is crucial for conserving resources and reducing environmental impact. However, the magnetic performance of recycled magnets produced from Hydrogen Processing of Magnetic Scrap (HPMS) powders is often diminished by high oxygen content and impurities. This study explores redesigning the microstructure of these recycled magnets to address performance limitations caused by non-magnetic impurities and ferromagnetic grain-boundary phases. Citric acid was used to selectively leach Nd-rich phases from the HPMS powder, producing a single-phase $RE_2Fe_{14}B$ powder. The investigation focused on replacing existing secondary phases with non-magnetic materials, including selected metals and rare-earth (RE) lean or RE-free alloys, which help lower the melting point of the diffusion source and potentially improve magnetic properties. Several methods were used to incorporate copper as a secondary phase, including electroless, electrochemical deposition, and a metallurgical approach. Additionally, a non-magnetic $Nd_{70}Cu_{30}$ low eutectic alloy was introduced as a secondary phase replacement. This alloy was added in varying amounts (0 to 30 wt.%) and consolidated through Spark Plasma Sintering (SPS). Full density (7.6 g/cm^3) was achieved with a 10 wt.% Nd-Cu addition, while remanence reached 1.04 T. Although increasing Nd-Cu content beyond 10 wt.% reduced the volume fraction of the $Nd_2Fe_{14}B$ hard-magnetic phase, remanence remained stable due to better grain crystallographic alignment. Coercivity improved significantly, from 50 to 826 kA/m, as Nd-Cu content increased from 2.5 to 30 wt.%, driven by oxygen redistribution and the formation of Nd_2O_3 in triple junctions. This led to enhanced grain boundary phases and improved wettability. This research contributes to advancing Nd-Fe-B magnet recycling, promoting sustainability, and expanding their industrial applications.

Kindly invited.